



Biofuels Research & Development

Michigan Agri-Energy Conference

March 14, 2007

Dan Radomski
Director, Industry Services
NextEnergy Center
313-833-0100 ext. 150
danr@NextEnergy.org
www.NextEnergy.org

What is NextEnergy?

- Non-profit corporation founded by the State of Michigan to advance the alternative energy industry and diversify Michigan's economy
 - Advanced power trains, distributed generation, renewable energy, clean fuels
 - Automotive, stationary, and portable applications
- Mission
 - To enable the commercialization of energy technologies that positively contribute to economic competitiveness, energy security, and the environment

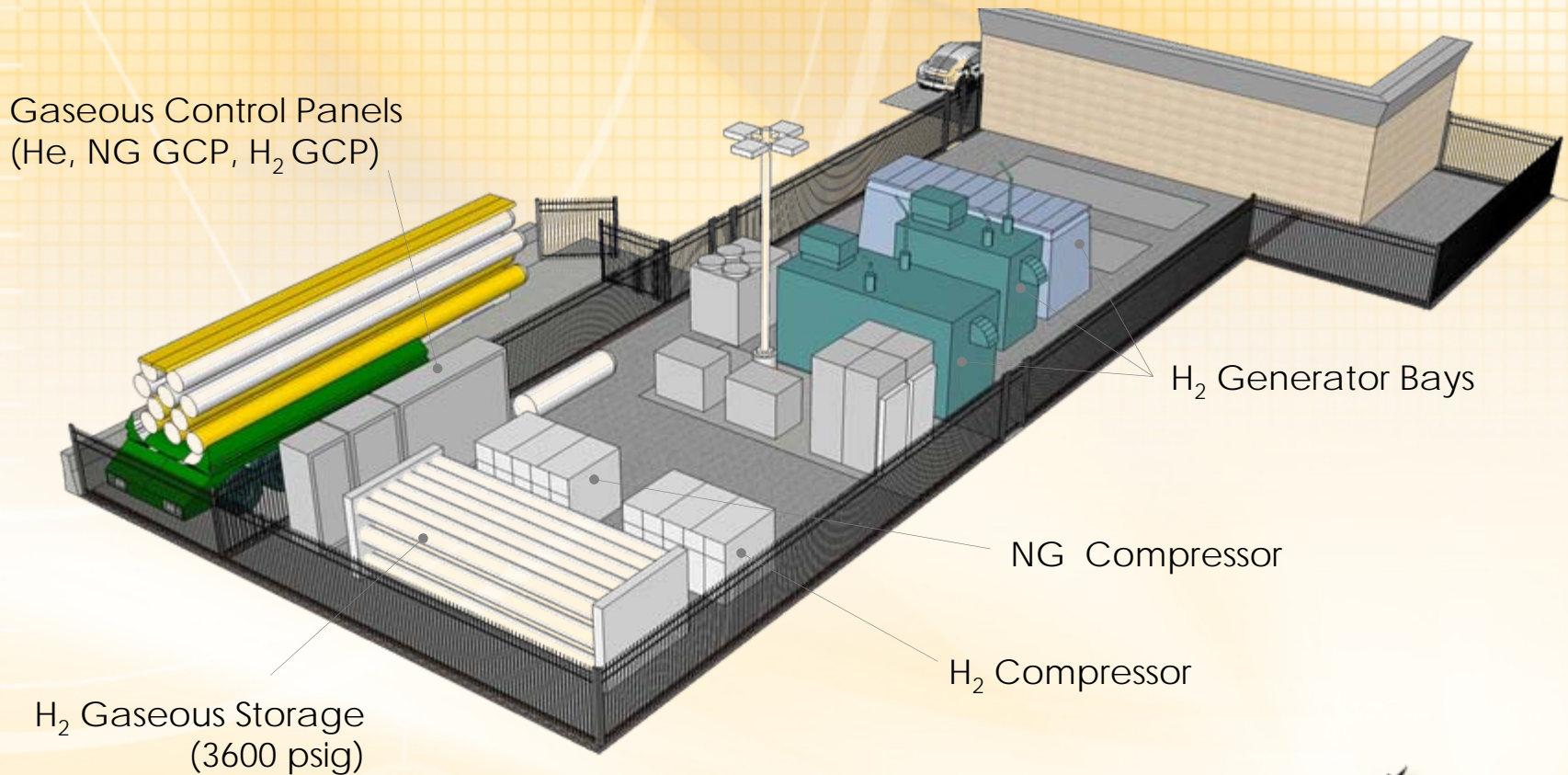
Stationary MicroGrid Power Pavilion



SMG Power Pavilion



Alternative Fuels Platform



SMG and AFP System Highlights

■ SMG

- Capable of handling up to 1.5 MW of power
- 9 test bays – 7 rentable
- CHP system
- Capable of grid islanded / grid parallel operation
- Multi-fuel capable including hydrogen, NG and liquid fuels

■ AFP

- Capable of handling up to 1.0 MW of power
- 6 test bays – 1 dedicated to storage technologies
- Vehicle Fueling Station
- Multi-fuel capable including hydrogen, NG and liquid fuels

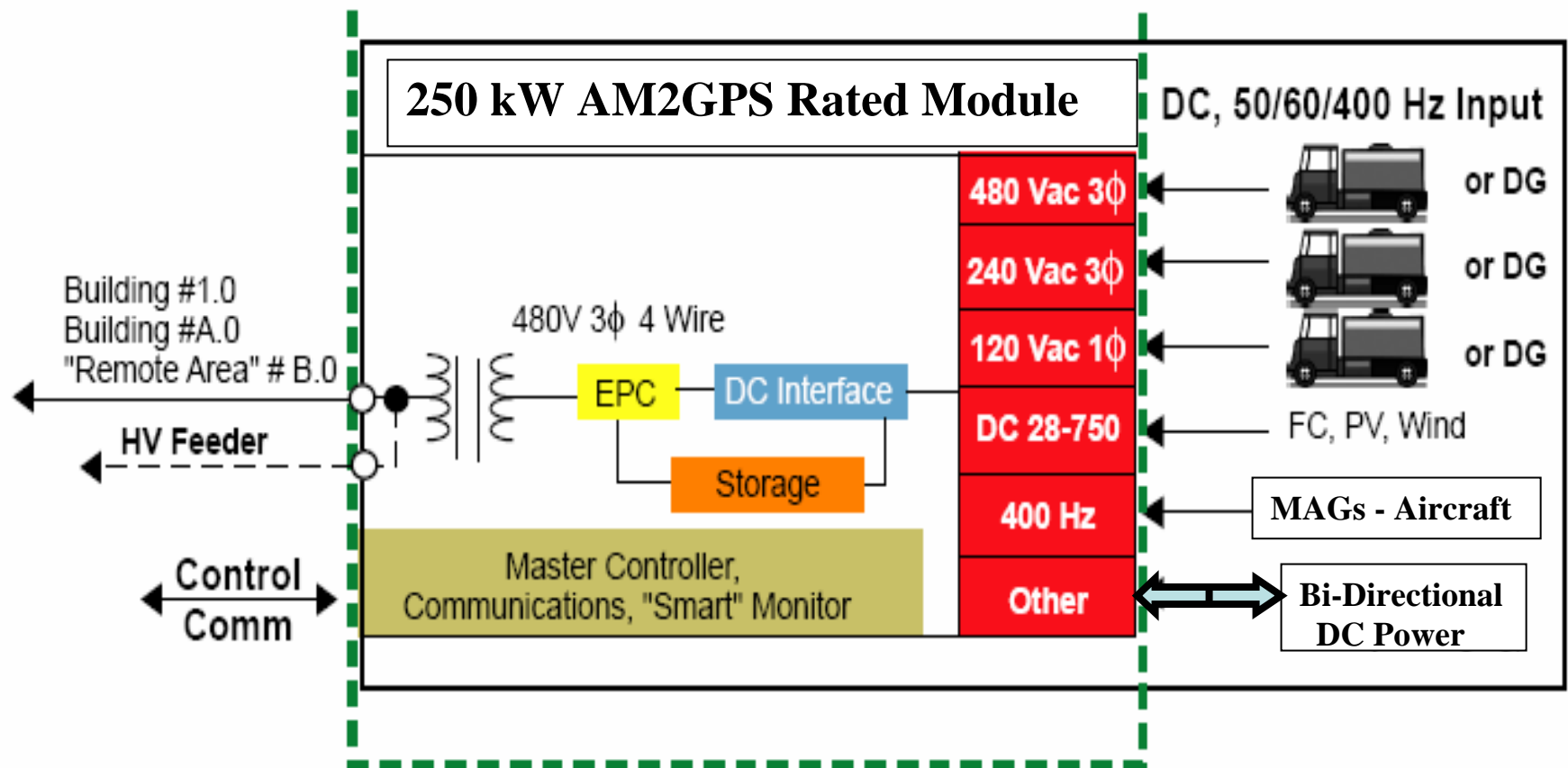
AM2GPS Subsystems

**Electronic Power Control & Conditioning (EPCC)
Subsystem**

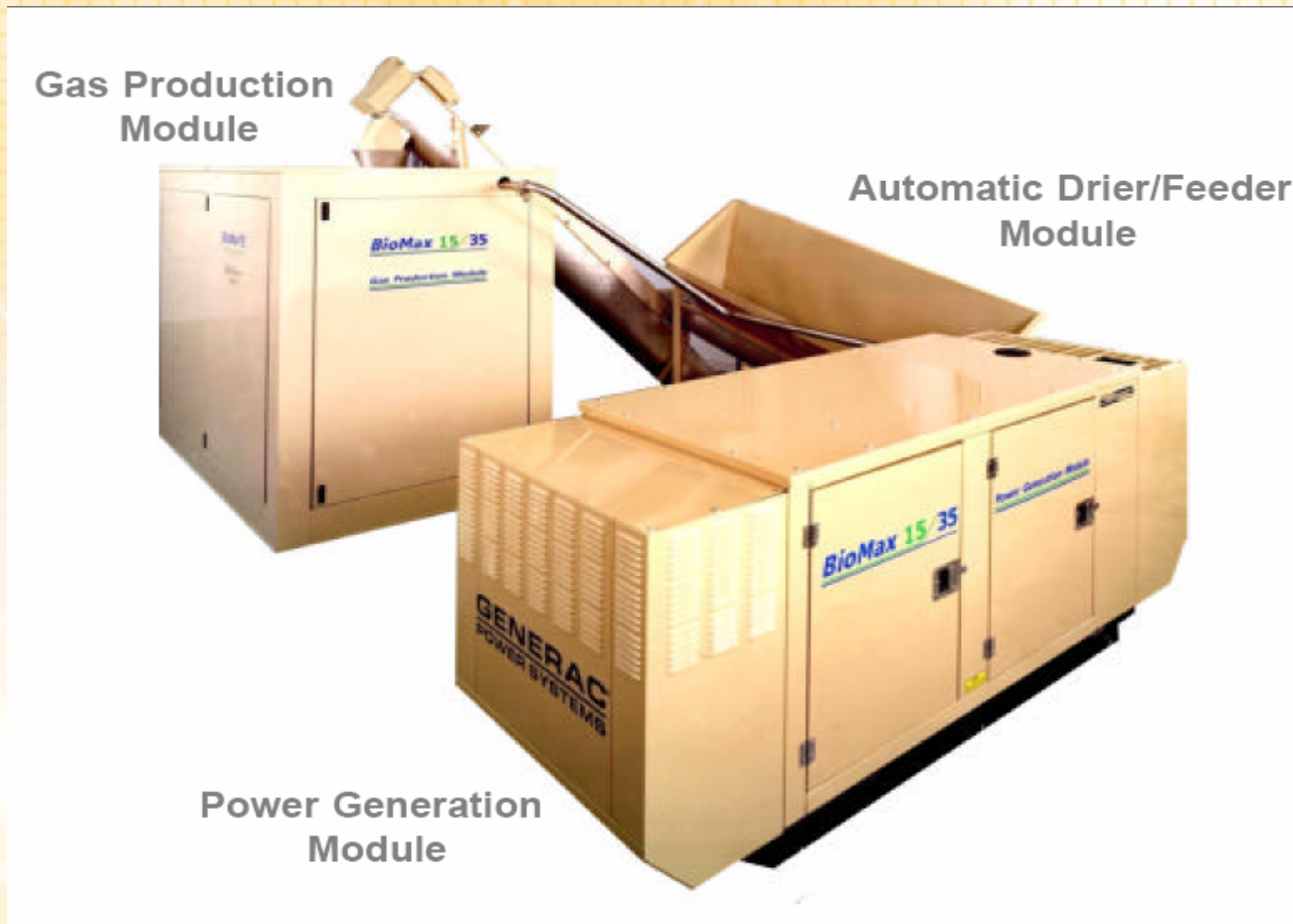
**Military Encampment Waste Electrical Power System
(MEWEPS) Subsystem**

Selfridge Site: 1500 kW Mobile MicroGrid

Application to Site with 250 kW Modules x Six (6)



Waste to Energy System Concept



MEWEPS Program Objectives

Biomass energy conversion subsystem that can be simultaneously deployed with the EPCC subsystem to convert Military Encampment Waste to Electrical Power (MEWEPS) or liquid synthetic fuel

Capability to:

- Accept military encampment waste including paper, fiberboard, plastic and food**
- Produce synthetic gas capable of being converted to liquid synthetic fuel or directly supplied to a standard military Tactical Quiet Generator**
- Produce electrical power via the TQC to provide 30 kW of electric power capable of being exported to the AM2GPS or a stand alone load.**

MEWEPS Outcomes

- Deployable Packaged System for Military, Homeland Security and First Responder Applications
- Reduce the logistics burden within the above applications
 - Reduce the amount of liquid fuel used for electrical power and heat production in the field
 - Minimize the manpower required for management of field waste
 - Convert waste into a resource Vs liability

Potential Commercial Applications

- Onsite Power Production using locally produced waste
 - System sized for facility and waste production
- If economically and environmentally feasible
 - Offset electrical power and heat productions
 - Minimize amount of waste removed from facilities to land fills
 - Applications for farming, remote areas and developing countries

Means of Producing Ethanol from Biomass & other Wastes

Thermochemical			Hydrolysis		
Technology	Pros	Cons	Technology	Pros	Cons
Gasification – Catalytic	Lower capital cost, feedstock flexibility, high yield per ton of feed	Tar production, requires gas cleanup, catalyst poisoning, catalyst disposal, production of mixture of low alcohols (i.e., impure product)	Dilute Acid Hydrolysis	Low capital cost, low acid consumption, public domain technology	Lower conversion efficiency, co-factor/toxin production
Gasification – Bioreactor	Lower capital cost, feedstock flexibility, high yield per ton of feed	Tar production, requires gas cleanup - bioreactor poisoning with real feedstocks.	Strong Acid Hydrolysis	Medium-high capital cost, low acid consumption	Low conversion efficiency, co-factor production
Fractionization - Mechanical	Recovery of pure components	Moderate capital cost, high energy cost	Concentrated Acid Hydrolysis	98% recycling of acid, high conversion efficiency, near zero liquid discharge	Moderately-high capital cost
Fractionization – Solvents	Recovery of pure components	Moderate capital cost, high energy cost	Enzymatic Hydrolysis	Enzyme cost reduced recently	NOT Suitable for MSW and Green wastes
			Hybrid – Dilute Acid/Enzymatic Hydrolysis	Enzyme cost reduced recently	Co-factor production

Source: BlueFire Ethanol website

National Cellulosic R&D

- **DOE Invests \$385 Million in Six Cellulosic Ethanol Projects**
 - Abengoa Bioenergy Biomass (Kansas)
 - 11.4 million gallons of ethanol annually and will use 700 tons per day of corn stover, wheat straw, milo stubble, switchgrass, and other feedstocks
 - ALICO, Inc. (Florida)
 - 13.9 million gallons of ethanol a year and 6,255 kilowatts of electric power, as well as 8.8 tons of hydrogen and 50 tons of ammonia per day. For feedstock, the plant will use 770 tons per day of yard, wood, and vegetative wastes and eventually energycane
 - BlueFire Ethanol (Southern CA)
 - 19 million gallons of ethanol a year. As feedstock, the plant would use 700 tons per day of sorted green waste and wood waste from landfills

National Cellulosic R&D

- **DOE Invests \$385 Million in Six Cellulosic Ethanol Projects**
 - **Broin Companies (Iowa)**
 - 125 million gallons of ethanol per year, of which roughly 25percent will be cellulosic ethanol. For feedstock in the production of cellulosic ethanol, the plant expects to use 842 tons per day of corn fiber, cobs, and stalks.
 - **Iogen Biorefinery Partners (Idaho)**
 - 18 million gallons of ethanol annually. The plant will use 700 tons per day of agricultural residues including wheat straw, barley straw, corn stover, switchgrass, and rice straw as feedstocks.
 - **Range Fuels (Georgia)**
 - 40 million gallons of ethanol per year and 9 million gallons per year of methanol. As feedstock, the plant will use 1,200 tons per day of wood residues and wood based energy crops.

National Bio-Fuel Energy Lab

- **Joint Development with NextEnergy and Wayne State University**
- **Technical Collaboration with Industry and Government within Specific Applications/Projects**

NBEL B20 Team and Roles

- **NextEnergy – Overall Program Mgt**
- **Wayne State University – Lab Operations and Engine Dyno Testing**
- **DaimlerChrysler Corp – Engine Controls; Vehicle, Engine and Fuels Expertise**
- **Robert Bosch Corp – Fuel Injection System Integration Expertise**

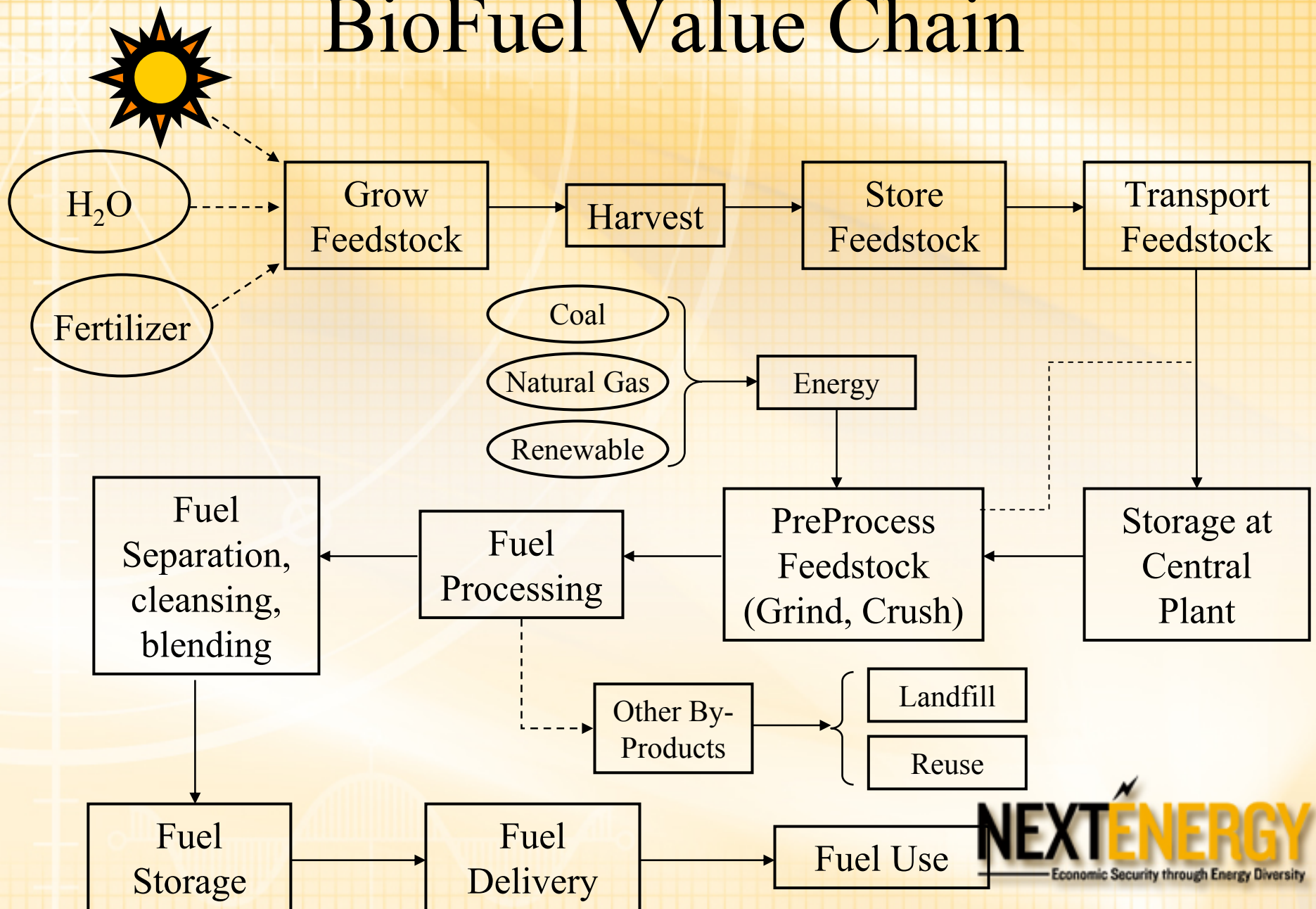
B20 Team and Roles Cont.

- **Delphi Corp – Exhaust System Component and Engine Expertise**
- **Biodiesel Industries, Inc. – Novel Fuel Production and Testing, Fuels Expertise**
- **Volkswagen of America – Engine/Vehicle Expertise**
- **Infineum – Fuel Correlation Testing and Additive Expertise**
- **US ARMY TARDEC – End User Feedback**

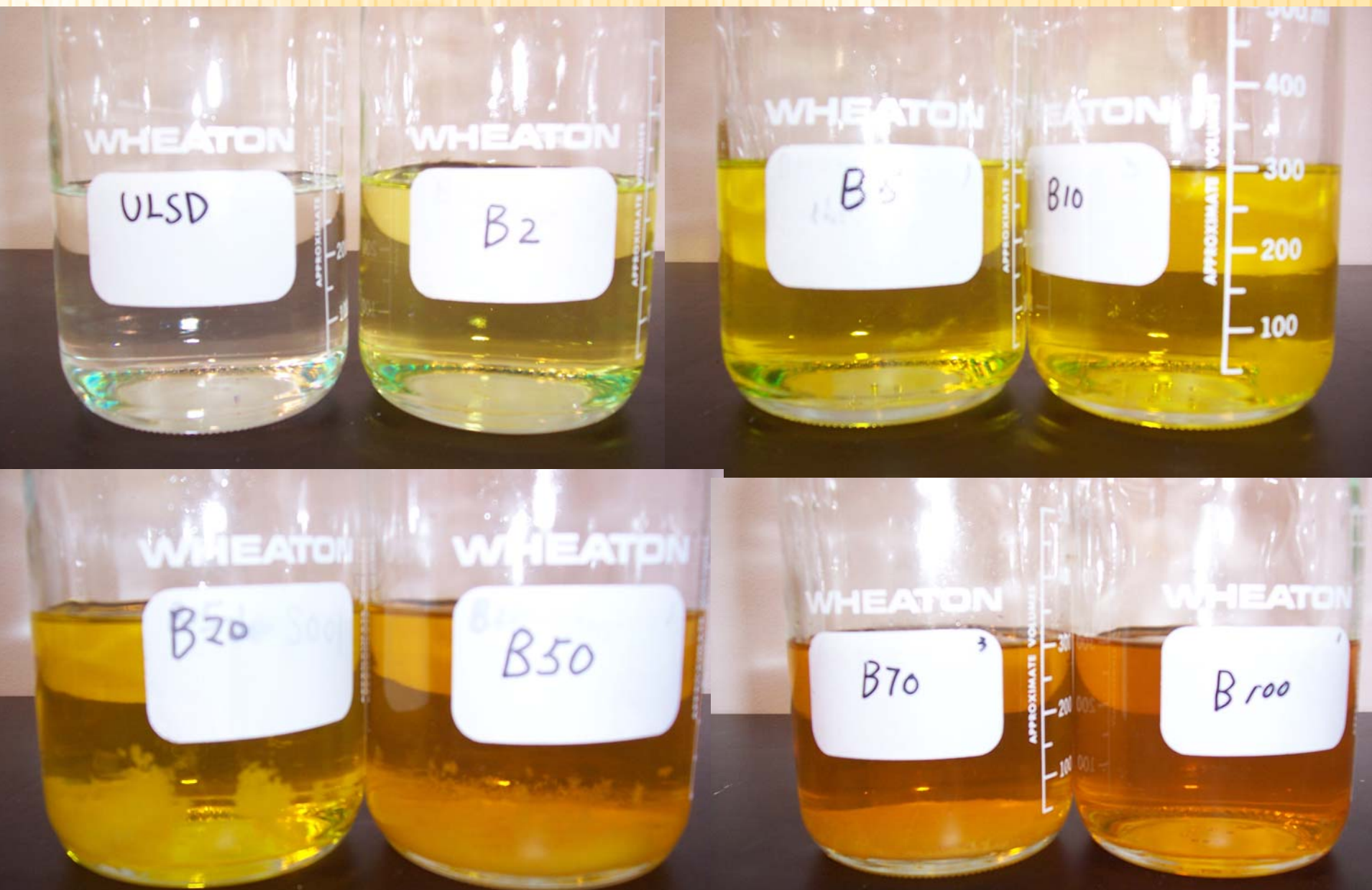
NBEL B20 Program Objectives

- **To establish a sound technical basis for biofuel that will accelerate the setting of industry specifications for 20% biodiesel fuel that is viable at all operating conditions.**
- **To gain a comprehensive understanding of composition-property-performance relationships for biofuels and through that basis to develop the next-generation of biodiesel with acceptable performance, cold flow and stability properties.**

BioFuel Value Chain



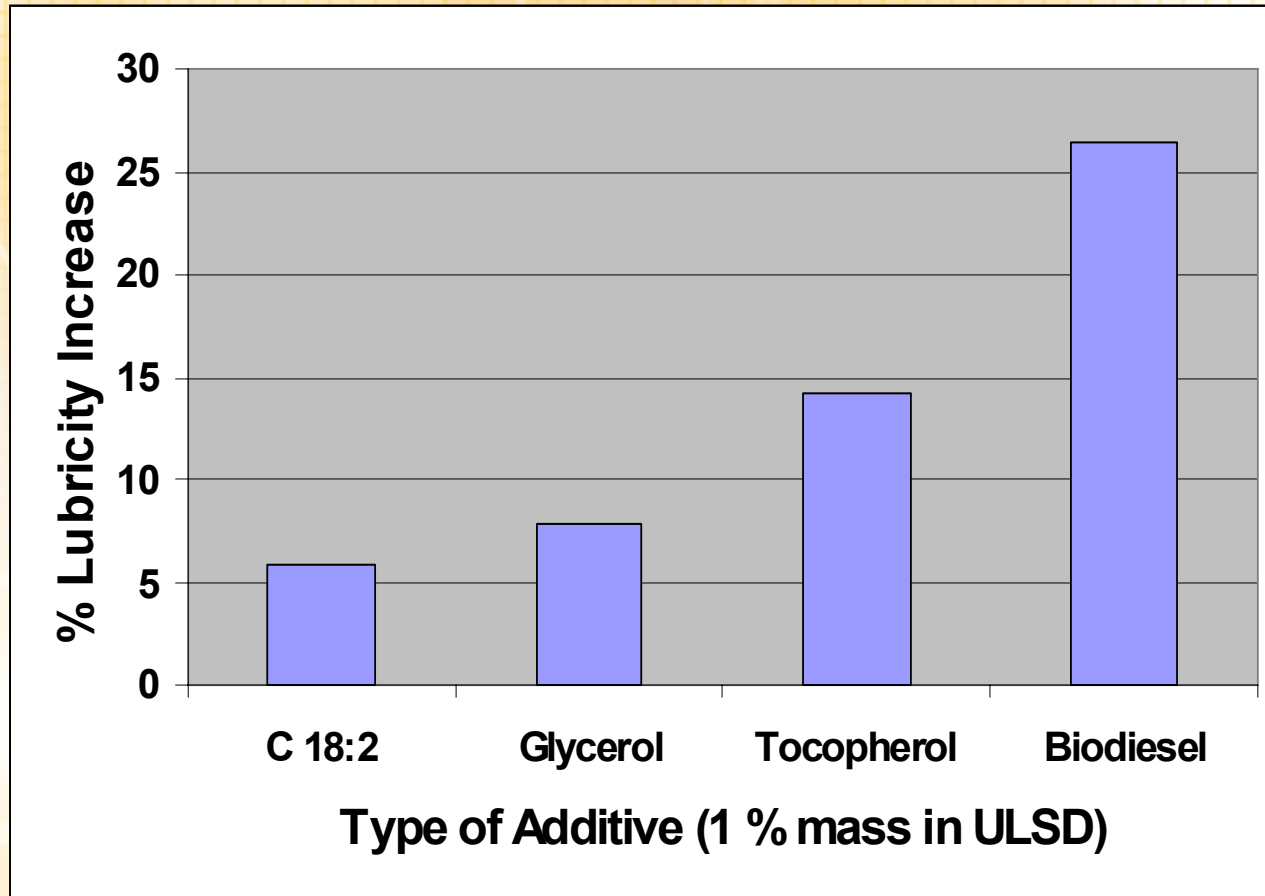
Physical Appearance _____ 4 °C-Soybean



Specific Tasks

- **Fuel Properties**
 - **Determine the effects of fatty acid ester distribution on: engine emissions and performance, oxidation stability, lubricity, and cold flow properties.**
 - **Evaluate long-term oxidative stability and cold flow properties of soy-based biodiesel and its blends under Michigan ambient conditions.**

Lubricity of Biodiesel Blends



Specific Tasks

- **Process Development**
 - **Develop a cost-effective heterogeneous catalysis process to produce quality biodiesel that meets ASTM standard.**
 - **Novel reactor design and development for custom biodiesel production.**

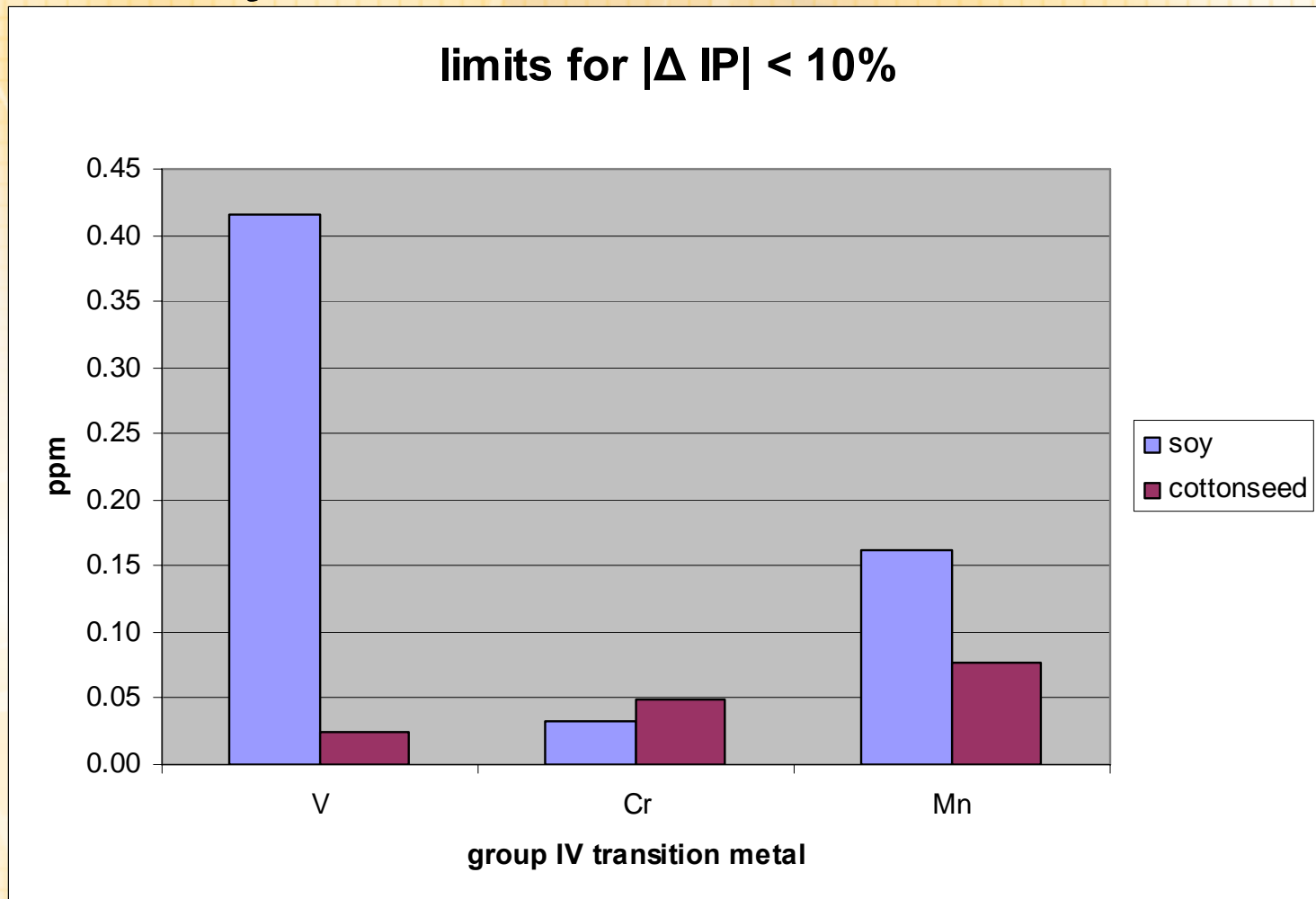
Specific Tasks (Contd.)

- **Additives Development**
 - **Evaluate the effect of metal concentration and solvency on B20 oxidative stability.**
 - **Develop new fuel additives or analyze current additives to enhance the overall B20 stability.**
 - **Evaluate the effectiveness of cold flow improvers on diesel, biodiesel and B20.**

Oxidative Stability of B100

- Study the effects of group IV transition metals (V, Cr, Mn, Fe, Co, Ni, Cu and Zn)
- Measure the change in oxidative stability with Rancimat®
- Determine limits of metal concentration that cause a change in oxidative stability of 10%

Comparison of B100 from soybean vs. cottonseed



Additional NBEL Projects

- **Synthetic Diesel Fuel Characterization and Testing**
 - **State of Michigan and US Army Sponsorship with Industry Participation**
- **Opportunities for fuel characterization and testing with various producers**

B20 Standard Program

- **Looking for Results To Date?**
- **Wayne State University**
 - **Steven Salley, Associate Dean Wayne State University Graduate School**

Michigan Accomplishments:

Ethanol Quick Stats

- 41 E- 85 pumps
 - More than 2,000 service stations offer 10% ethanol blended gasoline
 - 4 Ethanol plants operating (Caro, Woodbury, Blissfield and Albion)
 - 1 Ethanol plants under construction (Marysville)
 - 2 Ethanol plants waiting for permits (Watervliet and Ithaca)
 - 4 Ethanol plants proposed (Corunna, Alma, McBain and Manistee)
- Total ethanol fuel production capacity by end of 2007: 250 MMG

Michigan Accomplishments: Biodiesel Quick Stats

- 52 Biodiesel pumps
- 3 Biodiesel plants operating (Bangor, Gladstone and Milan)
- 1 Biodiesel plants under construction (Adrian)
- 4 Biodiesel plants proposed (Reading, Belleville, Ithaca and Detroit)
- Michigan produces 20 million gallons of biodiesel per year.

Renewable Fuels Package

- Renewable fuels in Michigan temporarily taxed (E-85) 7 cents less and (B5-20+) biodiesel blends 3 cents less than regular fuel
- State of Michigan installs renewable fueling infrastructure at DMB motor transport facility for state employees and vehicles.
- 10 new Renewable Energy Renaissance Zones created as incentives to encourage development of biofuels facilities in Michigan. Also, 10 more Ag Processing Renaissance Zones.
- Renewable Fuels Commission Created

The Future:

2007 State of the State Address

- Renewable Portfolio Standard
 - 10% 2015; 20% by 2025
- \$100 Million invested in Alternative Energy over the next 3 years
 - \$50 Million to commercialize pilot projects
 - \$12 Million Capitol Access Program
 - \$ 7-8 Million for pump conversions
 - \$20 Million Alternative Energy Venture Capitol Fund Partnership with NextEnergy and Nth Power
- Expanding Renewable Energy Renaissance Zones to cover wind and solar technologies

What's Next?

- Cellulosic Derived Fuels from Forestry Products
 - Market Research Group being established with MEDC
 - Road Map to capitalize on Michigan's indigenous resources
 - Commercialization Demonstration Projects
 - Job Creation

Michigan AET Support Network:

Collaborators

MTU

Program Collaborators

- Dedicated AET Research Centers
- Smartzones and Other Economic Development Organizations
- Universities

* Enabled through Michigan's 21st Century Jobs Fund initiative

